Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

POND

CODE 378

(no)

DEFINITION

A pond is a water impoundment made by constructing an embankment, by excavating a dugout, or by a combination of both.

In this standard, NRCS defines ponds constructed by the first method as embankment ponds, and those constructed by the second method as excavated ponds. Ponds constructed by both the excavation and the embankment methods are classified as embankment ponds if the depth of water impounded against the embankment at the auxiliary spillway elevation is 3 feet or more above the lowest original ground along the centerline of the embankment.

PURPOSE

This practice is used to accomplish one or more of the following purposes:

- Store water for livestock, fish and wildlife, recreation, fire control, erosion control or flow detention
- Store water for other uses such as improving water quality

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all excavated ponds. It also applies to embankment ponds that meet all of the criteria for low-hazard dams as listed below:

- The failure of the dam will not result in loss of life, damage to homes, commercial or industrial buildings, main highways, or railroads, or in interruption of the use or service of public utilities.
- The product of the storage times the effective height of the dam is less than 3,000 acre-feet^2. Storage is the capacity of the reservoir in acre-feet below the elevation of the crest of the lowest auxiliary spillway or the elevation of the top of the dam if there is no open channel auxiliary spillway. The effective height of the dam is the difference in elevation, in feet, between the lowest open channel auxiliary spillway crest and the lowest point in the original cross section taken on the centerline of the dam. If there is no open channel auxiliary spillway, use the lowest point on the top of the dam instead of the lowest open channel auxiliary spillway crest.
- The effective height of the dam is 35 feet or less.

CRITERIA

General Criteria Applicable to All Purposes

All federal, State and local requirements shall be addressed in the design.

Design a minimum sediment storage capacity equal to the design life of the structure, or provide for periodic cleanout. Protect the drainage area above the pond to prevent sedimentation from adversely affecting the design life.

Design measures necessary to prevent serious injury or loss of life in accordance with requirements of NRCS National Engineering Manual (NEM), Part 503, Safety.

Seed or sod the exposed surfaces of earthen embankments, earth spillways, borrow areas, and other areas disturbed during construction in accordance with the criteria in NRCS Conservation Practice Standard (CPS) Code 342, Critical Area Planting. When necessary to provide surface protection where climatic conditions preclude the use of seed or sod, use the criteria in CPS Code 484, Mulching, to install inorganic cover material such as gravel.

Cultural Resources
Evaluate the existence of cultural resources in the project area and any project impacts on such resources. Provide conservation and stabilization of archeological, historic, structural, and traditional cultural properties when appropriate.

Site Conditions
Select or modify the site to allow runoff from the design storm to safety pass through (1) a natural or constructed auxiliary spillway, (2) a combination of a principal spillway and an auxiliary spillway, or (3) a principal spillway.

Select a site that has an adequate supply of water for the intended purpose via surface runoff, groundwater, or a supplemental water source. Water quality must be suitable for its intended use.

Reservoir
Provide adequate storage volume to meet user demands for all intended purposes. Account for sedimentation, season of use, evaporation loss, and seepage loss when computing the storage volume. If surface runoff is the primary source of water for a pond, the soils shall be impervious enough to prevent excessive seepage losses or shall be of a type that sealing is practicable.

Additional Criteria for Embankment Ponds

Geological Investigations
Use pits, trenches, borings, and reviews of existing data or other suitable means of investigation to characterize materials within the embankment foundation, auxiliary spillway, and borrow areas. Classify soil materials using the Unified Soil Classification System (ASTM D2487).

Guidance for geological investigations may be found in the Minnesota Supplement to NEH Part 631, Chapter 2 – MN NRCS Guide to Subsurface Investigation.

Foundation Cutoff
Design a cutoff of relatively impervious material under the dam and up the abutments as required for preventing seepage. Locate the cutoff at, or upstream from, the centerline of the dam. Extend the cutoff deep enough to intercept flow and connect with a relatively impervious layer. Combine seepage control with the cutoff as needed. Use a cutoff bottom width adequate to accommodate the equipment used for excavation, backfill, and compaction operations. Design cutoff side slopes no steeper than one horizontal to one vertical.

Seepage Control
Include seepage control if (1) foundation cutoff does not intercept pervious layers, (2) seepage could create undesired wet areas, (3) embankment stability requires seepage control, or (4) special problems require drainage for a stable dam. Control seepage by (1) foundation, abutment, or embankment filters and drains; (2) reservoir blanketing; or (3) a combination of these measures.

Top Width
Table 1 provides the minimum top widths for dams of various total heights. Total height is the vertical distance between the settled top of the dam and the lowest elevation at the downstream toe.

Design a minimum width of 16 feet for one-way traffic and 26 feet for two-way traffic for the top of dams used as public roads. Design guardrails or other safety measures where necessary and follow the requirements of the responsible road authority. For dams less than 20 feet in total height, maintenance considerations or construction equipment limitations may require increased top widths from the minimum shown in table 1.

Table 1. Minimum top width for dams.

Total height of dam *(feet)*	Top width *(feet)*
Less than 10	6
10–14.9	8
15–19.9	10
20–24.9	12
25–34.9	14
35 or more	15

Side Slopes
Design each side slope with a ratio of two horizontal to one vertical or flatter. Design the sum of the upstream- and downstream-side slopes with a ratio of five horizontal to one vertical or flatter. As required, design benches or flatten side slopes to assure stability of all slopes for all loading conditions.

Slope Protection
Design special measures such as berms, rock riprap, sand-gravel, soil cement, or special vegetation as needed to protect the slopes of the dam from erosion. Use NRCS Engineering Technical Release (TR) 210 56, A Guide for Design and Layout of Vegetative Wave Protection for Earth Dam Embankments, and TR-210-69, Riprap for Slope Protection against Wave Action, as applicable.

For ponds with a permanent pool area of 2 acres or more, protection shall be provided across the earth fill at normal pool elevation (elevation of the inlet of the mechanical spillway) on the upstream side of the earth fill extending to the abutments. This protection may be: (1) a berm having a width of at least 5 feet; or (2) other suitable slope protection such as riprap.

On structure with drop inlets, the riser shall be protected from damage by ice or floating debris by one of the following options: (1) a berm at least 5 feet wide or other suitable slope protection, such as rock riprap, shall be constructed across the earth fill at the normal pool elevation (elevation of the mechanical spillway) on the upstream side of the earth fill extending to the abutments; or (2) a semi-circular berm extending not less than 5 feet from the riser inlet shall be installed. A berm (full or semi-circular) should be considered with hood inlets for ice protection where the permanent pool level is maintained at the hood inlet elevation. The junction between the earth fill and abutments will normally carry runoff from berms and adjacent areas and shall be shaped and vegetated to minimize erosion.

Freeboard
Design a minimum of 1.0 feet of freeboard between design high-water-flow elevation in the auxiliary spillway and the top of the settled embankment. Design a minimum 2.0 feet of elevation difference between the crest of the auxiliary spillway and the top of the settled embankment when the dam has more than a 20-acre drainage area or more than 20 feet in effective height. Design a minimum of 1.0 feet of freeboard above the peak elevation of the routed design hydrograph to the top of the settled embankment, when the pond has no auxiliary spillway.

Settlement
Increase the height of the dam by the amount needed to ensure that the settled top elevation of the dam equals or exceeds the design top elevation. Design a minimum of 5 percent of the total height of the dam associated with each dam cross section, except where detailed soil testing and laboratory analyses or experience in the area shows that a lesser amount is adequate.

Principal Spillway and Pipe Conduit through the Embankment
Design a pipe conduit with needed appurtenances through the dam, except where rock, concrete, or other types of lined spillways are used, or where a vegetated or earth spillway can safely handle the rate and duration of base flow.

Design a minimum of 0.5-feet difference between the crest elevation of the auxiliary spillway and the crest elevation of the principal spillway when the dam has a drainage area of 20 acres or less. Design a minimum of 1.0-foot difference when the dam has a drainage area of over 20 acres.

Provide an antivortex device for a pipe conduit designed for pressure flow. Design the inlet and outlet to function for the full range of flow and hydraulic head anticipated.

Design adequate pipe conduit capacity to discharge long-duration, continuous, or frequent flows without causing flow through the auxiliary spillway. Design a principal spillway pipe with a minimum inside diameter of 4 inches. Design pipe with a minimum inside diameter of 1-1/4 inches for water supply pipes or for pipes used for any other purpose.

Design pipe conduits using ductile iron, welded steel, corrugated steel, corrugated aluminum, reinforced concrete (pre-cast or site-cast), or plastic. Do not use cast iron or unreinforced concrete pipe if the dam is 20 feet or greater in total height.

Design and install pipe conduits to withstand all external and internal loads without yielding, buckling, or cracking. Design rigid pipe for a positive projecting condition. Design flexible pipe conduits in accordance with the requirements of NRCS National Engineering Handbook (NEH), Part 636, Chapter 52, Structural Design of Flexible Conduits.

Design connections of flexible pipe to rigid pipe or other structures to accommodate differential movements and stress concentrations. Design and install all pipe conduits to be watertight using couplings, gaskets, caulking, water stops, or welding. Design joints to remain watertight under all internal and external loading including pipe elongation due to foundation settlement.

Design a concrete cradle or bedding for pipe conduits if needed to reduce or limit structural loading on pipe and improve support of the pipe.

Design outlet structures, such as cantilever pipe outlet sections and impact basins, to dissipate energy as needed.

Table 2. Acceptable PVC pipe use in earth dams [1]

Nominal pipe size	Schedule for standard dimension ratio (SDR)	Maximum depth of fill over pipe
in		*ft*
4 or less	Schedule 40	15
	Schedule 80	20
	SDR 26	10
6,8,10,12	Schedule 40	10
	Schedule 80	15
	SDR 26	10

[1] Polyvinyl chloride pipe, PVC 1120 or PVC 1220, conforming to ASTM-D-1785 or ASTM-D-2241.

Table 3. Minimim gage for corrugated metal pipe [2-2/3-in x 1/2-in corrugations][1]

Fill	**Minimum gauge for steel pipe with diameter (in) of ___**					
height (ft)	21 and less	24	30	36	42	48
1 - 15	16	16	16	14	12	10
15 - 20	16	16	16	14	12	10
20 - 25	16	16	14	12	10	10

Fill	**Minimum thickness (in) of aluminum pipe[2] with diameter (in) of ___**			
height (ft)	21 and less	24	30	36
1 - 15	0.06	0.06	0.075	0.075
15 - 20	0.06	0.075	0.105	0.105
20 - 25	0.06	0.105	0.135	——[3]

[1] Pipe with 6-, 8-, and 10-inch diameters has 1-1/2 in x ¼-inch corrugations.

[2] Riveted or helical fabrication.

[3] Not permitted

Design the minimum spillway capacities for class (A) dams having a product of storage times the effective height of the dam of less than 3000 and an effective height of 35 feet or less in accordance with Table 4.

Corrosion Protection
Provide protective coatings for all steel pipe and couplings in areas that have traditionally experienced pipe corrosion or in embankments with saturated soil resistivity less than 4,000 Ohm-cm or soil pH less than 5. Protective coatings may include asphalt, polymer over galvanizing, aluminized coating, or coal tar enamel.

Ultaviolet Protection
Use ultraviolet-resistant materials for all plastic pipe or provide coating or shielding to protect plastic pipe exposed to direct sunlight.

Cathodic Protection
Provide cathodic protection for coated welded steel and galvanized corrugated metal pipe where soil and resistivity studies indicate that the pipe needs a protective coating and where the need and importance of

the structure warrant additional protection and longevity. If the original design and installation did not include cathodic protection, consider establishing electrical continuity in the form of joint-bridging straps on pipes that have protective coatings. Add cathodic protection later if monitoring indicates the need.

Filter Diaphragms

When the effective height of the dam is 15 feet or greater and the effective storage of the dam is 50 acre-ft. or more, provide filter diaphragms to control seepage on all pipes extending through the embankment with inverts below the peak elevation of the routed design hydrograph. Design filter diaphragms or alternative measures as needed to control seepage on pipes extending through all other embankments or for pipes with inverts above the peak elevation of the routed design hydrograph.

Design the filter diaphragm in accordance with the requirements of NEH, Part 628, Chapter 45, Filter Diaphragms. Locate the filter diaphragm immediately downstream of the cutoff trench, but downstream of the centerline of the dam if the foundation cutoff is upstream of the centerline or if there is no cutoff trench.

To improve filter diaphragm performance, provide a drain outlet for the filter diaphragm at the downstream toe of the embankment. Protect the outlet from surface erosion and animal intrusion.

Ensure filter diaphragm functions both as a filter for adjacent base soils and as a drain for seepage that it intercepts. Materials for the filter diaphragm shall meet the requirements of NEH Part 628, Chapter 45, Filter Diaphragms, Section 628.4503(d), Filter and Drain Gradation.

When using anti-seep collars in lieu of a filter diaphragm, ensure a watertight connection to the pipe. Limit the maximum spacing of the anti-seep collars to 14 times the minimum projection of the collar measured perpendicular to the pipe, or 25 feet, whichever is less. Locate anti-seep collars no closer than 10 feet apart. Use a collar material that is compatible with the pipe material.

When using anti-seep collars, design the collars to increase the seepage path along the pipe within the fill by at least 15 percent.

Trash Guard

Install a trash guard at the riser inlet to prevent clogging of the conduit, unless the watershed does not contain trash or debris that could clog the conduit.

Pool Drain

Provide a pipe with a suitable valve to drain the pool area if needed for proper pond management or if required by State law. The designer may use the principal spillway conduit as a pond drain if it is located where it can perform this function.

Auxiliary Spillways

A dam must have an open channel auxiliary spillway, unless the principal spillway is large enough to pass the peak discharge from the routed design hydrograph and the trash that comes to it without overtopping the dam. The minimum criteria for acceptable use of a closed conduit principal spillway without an auxiliary spillway consist of a conduit with a cross-sectional area of 3 feet^2 or more, an inlet that will not clog, and an elbow designed to facilitate the passage of trash.

Design the minimum capacity of a natural or constructed auxiliary spillway to pass the peak flow expected from a total design storm of the frequency and duration shown in table 2, less any reduction creditable to the conduit discharge and detention storage.

Table 4 assumes an auxiliary spillway in good condition. A good spillway is one which will support vegetation (or is otherwise protected) and has exit slopes which lie within the ranges as defined in EFH, Exhibit 11-2, Tables 3A-3B. A poor auxiliary spillway is one which will likely sustain damage from an appreciable flow but will protect the principal spillway structure and embankment during the passage of a single design storm. Structures with a poor auxiliary spillway must increase the principal spillway design storm in Table 4 by one frequency level. (In other words, a site with a good auxiliary spillway may have a

10 year frequency design storm. If that same site has a poor auxiliary spillway, a 25-year design storm must be used.)

Design the auxiliary spillway to safely pass the peak flow through the auxiliary spillway, or route the storm runoff through the reservoir. Start the routing either with the water surface at the elevation of the crest of the principal spillway or at the water surface after 10 days' drawdown, whichever is higher. Compute the 10-day drawdown from the crest of the auxiliary spillway or from the elevation attained from impounding the entire design storm, whichever is lower. Design the auxiliary spillway to pass the design flow at a safe velocity to a point downstream where the flow will not endanger the dam.

A constructed auxiliary spillway consists of an inlet channel, a control section, and an exit channel. Design the auxiliary spillway with a trapezoidal cross section. Locate the auxiliary spillway in undisturbed or compacted earth or in-situ rock. Design for stable side slopes for the material in which the spillway is to be constructed. Design a minimum bottom width of 10 feet for dams having an effective height of 20 feet or more.

Design a level inlet channel upstream from the control section for the distance needed to protect and maintain the crest elevation of the spillway. If necessary, curve the inlet channel upstream of the level section to fit existing topography. Design the exit channel grade in accordance with NEH Part 628, Chapter 50, Earth Spillway Design, or with equivalent procedures.

Seeding and Mulching
An adequate cover of grass shall be established on the exposed surfaces of the embankment, borrow areas, and the auxiliary spillway. In some cases, temporary vegetation or mulching may be used until conditions are right for establishment of permanent vegetation. For seeding specifications, see Standard 342, Critical Area Planting. For mulching specifications, see Standard 484, Mulching.

Structural Auxiliary Spillways
When used for principal spillways or auxiliary spillways, design chute spillways or drop spillways according to the principles set forth in NEH, Part 650, Engineering Field Handbook; and NEH, Section 5, Hydraulics; Section 11, Drop Spillways; and Section 14, Chute Spillways. Design a structural spillway with the minimum capacity required to pass the peak flow expected from a total design storm of the frequency and duration shown in table 4, less any reduction creditable to the conduit discharge and detention storage.

Additional Criteria for Excavated Ponds

Runoff
Design a minimum of 1.0 feet of freeboard above the peak elevation of the routed design hydrograph. Design a pipe and auxiliary spillway that will meet the capacity requirements of table 4. Consider runoff flow patterns when locating the excavated pond and placing the spoil.

Side Slopes
Design stable side slopes in the excavated area no steeper than one horizontal to one vertical.

Minimum size
Excavated ponds receiving their water supply from surface runoff must have a minimum dimension of 10 feet by 10 feet at a depth of 8 feet below the overflow level. Check pond capacity to insure that an adequate supply of water is available for livestock use (see section below). This minimum size requirement does not apply to ponds constructed for wildlife. The criteria in Standard 644, Wildlife Wetland Habitat Management, apply for the minimum size of a wildlife structure. Excavated ponds receiving their water supply from ground water shall have a minimum dimension of 8 feet by 8 feet at a water depth of 4 feet. If the water supply is adequate, criteria on water capacities below do not apply to excavated ponds fed by ground water.

Seeding
All areas disturbed during construction are to be seeded to an erosion resistant mix specified in the construction documents.

Watering Ramp
When wildlife or livestock need access to stored water, use the criteria in NRCS CPS Code 614, Watering Facility, to design a watering ramp.

Inlet Protection
Protect the side slopes from erosion where surface water enters the pond in a natural or excavated channel.

Excavated Material
Place the material excavated from the pond so that its weight does not endanger the stability of the pond side slopes and so that the soil will not wash back into the pond by rainfall. Dispose of excavated material in one of the following ways:

- Uniformly spread to a height that does not exceed 3 feet, with the top graded to a continuous slope away from the pond.
- Uniformly place or shape reasonably well, with side slopes assuming a natural angle of repose. Place excavated material at a distance equal to the depth of the pond, but not less than 12 feet from the edge of the pond.
- Shape to a designed form that blends visually with the landscape.
- Provide for low embankment construction and leveling of surrounding landscape.
- Haul material offsite.

Table 4. Minimum spillway capacity

			Minimum principal spillway design storm[2]		Minimum auxiliary spillway design storm[2]	
Drainage area	Effective height of dam[1]	Maximum Storage	Frequency	Minimum duration	Frequency	Minimum duration
acre	*ft*	*ac-ft*	*yr*	*hr*	*yr*	*hr*
20 or less	0-20	50	*	24	10	24
20 or less	20-35	50	2	24	25	24
20-80	0-20	50	5	24	25	24
20-80	20-35	50	5	24	50	24
80-250	0-20	50	10	24	25	24
80-250	20-35	50	10	24	50	24
All others	0-35	any	25	24	50	24

* A principal spillway is required on all embankment ponds except where the drainage area is less than 20 acres AND there is no spring flow or base flow AND the auxiliary spillway is in good condition. A trickle tube is required if the site has no principal spillway.

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CONSIDERATIONS

General Considerations

Water Capacity for All Ponds

When used for stock watering purposes, the pond storage capacity should be based upon providing water requirements for livestock estimated on the following basis (Values should be increased for hot summer months.)

1. Cow or horses — 10 to 12 gallons daily.
2. Heavy milk-producing cows — 18 to 24 gallons daily.
3. Hogs or sheep - 2.5 to 3 gallons daily.
4. Poultry - 5 to 7 gallons daily per 100 chickens.
5. Provide for a 180 day drought period.
6. When the pond depends upon surface runoff, allow approximately 3 feet for seepage and evaporation.

When the primary purpose is for stock watering, the minimum surface area at normal water level shall be 0.15 acre. At least 0.04 acre surface area at normal water level (25 percent of surface area if practical) shall have a minimum depth of 8 feet. When the underlying material prevents excavation to the 8-foot depth, at least 0.08 acre surface area (50 percent if practicable) shall have a minimum depth of 6 feet.

If livestock are to water directly from the pond, an approach ramp must be constructed with a slope of 4:1 or 5:1. If the pond is fenced, the ramp shall be graveled, paved or otherwise prepared to provide solid footing and shall be at least 16 feet wide. Any permanent system used to pump water from a pond to a tank should be protected from damage by freezing. The intake should have a filter to prevent pipe clogging and the system must be large enough to meet the watering requirements.

Urban Applications

Urban sites frequently are a higher risk than rural sites. Consideration should be given to public safety, utility locations, vandalism, and higher property values that may increase damages from a potential overtopping condition.

Visual Resource Design

Carefully consider the visual design of ponds in areas of high public visibility and those associated with recreation. The shape and form of ponds, excavated material, and plantings are to relate visually to their surroundings and to their function.

Shape the embankment to blend with the natural topography. Shape the edge of the pond so that it is generally curvilinear rather than rectangular. Shape excavated material so that the final form is smooth, flowing, and fitting to the adjacent landscape rather than angular geometric mounds. If feasible, add islands to provide visual interest and to attract wildlife.

Fish and wildlife

Locate and construct ponds to minimize the impacts to existing fish and wildlife habitat.

When feasible, retain structures such as trees in the upper reaches of the pond and stumps in the pool area. Shape upper reaches of the pond to provide shallow areas and wetland habitat.

If operations include stocking fish, use CPS Code 399, Fishpond Management.

Vegetation

Stockpile topsoil for placement on disturbed areas to facilitate revegetation.

Consider selecting and placing vegetation to improve fish habitat, wildlife habitat and species diversity.

Water quantity
Consider effects upon components of the water budget, especially—

- Effects on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and groundwater recharge.
- Effects on downstream flows and impacts to environment such as wetlands, aquifers, and social and economic impacts to downstream uses or users.
- Variability of effects caused by seasonal or climatic changes.

Water quality
Consider the effects of—

- Erosion and the movement of sediment, pathogens, and soluble and sediment-attached substances that runoff carries.
- Soil water level control on the salinity of soils, soil water, or downstream water.
- Water levels on soil nutrient processes such as plant nitrogen use or denitrification.
- Wetlands and water-related wildlife habitats.
- Water-level control on the temperatures of downstream water to prevent undesired effects on aquatic and wildlife communities.
- Short-term and construction-related effects of this practice on the quality of downstream watercourses.
- Potential for earth moving to uncover or redistribute toxic materials.
- Livestock grazing adjacent to the pond. Consider fencing to keep livestock activities out of direct contact with the pond and dam.

PLANS AND SPECIFICATIONS

Prepare plans and specifications that describe the requirements for applying the practice according to this standard. As a minimum, include the following items:

- A plan view of the layout of the pond and appurtenant features
- Typical profiles and cross sections of the principal spillway, auxiliary spillway, dam, and appurtenant features as needed
- Structural drawings adequate to describe the construction requirements
- Requirements for vegetative establishment and/or mulching, as needed
- Safety features
- Site-specific construction and material requirements

OPERATION AND MAINTENANCE

Prepare an operation and maintenance plan for the operator.

As a minimum, include the following items in the operation and maintenance plan:

- Periodic inspections of all structures, earthen embankments, spillways, and other significant appurtenances
- Prompt repair or replacement of damaged components
- Prompt removal of sediment when it reaches predetermined storage elevations
- Periodic removal of trees, brush, and undesirable species
- Periodic inspection of safety components and immediate repair if necessary
- Maintenance of vegetative protection and immediate seeding of bare areas as needed

REFERENCES

American Society for Testing and Materials. Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System), ASTM D2487. West Conshohocken, PA.

USDA NRCS. Engineering Technical Releases, TR-210-60, Earth Dams and Reservoirs. Washington, DC.

USDA NRCS. National Engineering Handbook (NEH), Part 628, Dams. Washington, DC.

USDA NRCS. NEH, Part 633, Soil Engineering. Washington, DC.

USDA NRCS. NEH, Part 636, Structural Engineering. Washington, DC.

USDA NRCS. NEH, Part 650, Engineering Field Handbook. Washington, DC.

USDA NRCS. National Engineering Manual. Washington, DC.